



Guidelines and Health Conditions Related to Timing of Early Infant Feeding: A Review

AN ASPHN BRIEF - FALL 2018

Historically in the United States, medical and public health professionals have focused child health efforts and interventions within predetermined life-cycle states such as prenatal, pregnancy, infancy, early childhood, etc. The global community defines a more specific window of time, the **first 1,000 days of life**. The first 1,000 days of life, the time span between a woman's pregnancy and her child's 2nd birthday, has long been a focus of international child health. "Nutrition during pregnancy and in the first years of a child's life provides the essential building blocks for brain development, healthy growth and a strong immune system. In fact, a growing body of scientific evidence shows that the foundations of a person's lifelong health — including their predisposition to obesity and certain chronic diseases — are largely set during this 1,000 day window."¹

Ten years ago, the *Lancet* Maternal and Child Nutrition Series concluded its first paper confirming the focus on "pregnancy and the first 2 years of life, the crucial 1,000

days."² Five years later, new evidence prompted the updated 2013 Maternal and Child Nutrition Series paper to further emphasize the "*nutritional* conditions at the time of conception and during pregnancy, as important for fetal growth, and subsequent early childhood survival, growth, and development." Fetal growth restriction and poor growth early in infancy are now recognized as important determinants of overweight and obesity in older children and adults.²

In the United States, policy makers and institutions have recently prioritized the first 1,000 days by developing new US Dietary Guidelines to now include pregnancy and children up to 2 years of age. With mounting impetus to streamline preventative efforts in a relatively short time span, public health professionals should examine infant feeding practices with a critical eye, focusing on both the negative consequences and protective factors of early and late introduction of complementary foods.

The purpose of this document is to provide public health nutritionists and other professionals with brief, relevant findings and proposed supportive measures to address infant feeding practices. This includes the timing of complementary foods and the link to health conditions. Although limited research exists supporting the order and method of infant feeding, evidence regarding timing is the most valid. Much of the recent information on infant feeding practices, such as the timing of complementary foods or order of foods, varies based on the baby's first food (breastfeeding or infant formula, duration and extent of breastfeeding).

— Contents —

This document includes the most recent findings and guidelines necessary for public health nutritionists, including:

- A brief summary of infant feeding guidelines regarding the introduction of complementary foods from historical, present, and future perspectives
- Highlighting relevant research describing the impact of introduction of complementary foods on long-term outcomes, such as obesity/overweight, allergies, and anemia
- Summarizing information on these three aforementioned health conditions into applicable messages for public health nutritionists
- Connecting the overarching relationship of breastfeeding to these aforementioned health conditions
- Offering additional resources to provide further knowledge concerning infant feeding

This document provides highlights of current and emerging data, but it is not an exhaustive list of all significant data. While much of the information provided is based on new data, some older data referenced throughout remains relevant. The brief is intended for public health professionals with a working knowledge of the history and complexities surrounding infant feeding practices.

Key Terms



Complementary feeding:

a process that starts when human milk or infant formula is complemented by other foods and drinks and ends when the child transitions fully to table foods (typically to 24 months of age).³

Complementary foods:

any food (solid or liquid) other than breast milk or infant formula that are provided when milk alone is no longer sufficient.^{4,5}

Exclusive breastfeeding:

feeding only breast milk (human milk), not any other foods or liquids (including infant formula or water), except for medications or vitamin and mineral supplements (CDC - Breastfeeding Support)

Weaning:

process of changing an infant's diet from breast milk to other foods and drinks (CDC - Breastfeeding Support)



If we could focus educational, policy and financial support towards the most opportune window of time in an individual's life, the magnitude of impact could create a pivot point in our nation's health and well-being.

GENERAL GUIDANCE

— Background —



Background

Evolving Guidelines That Indicate the Importance of Timing

Guidelines for early infant feeding practices have drastically changed throughout the last 50 years to adapt with emerging research and changing environment.⁶ In the 1960s, infants were typically introduced to solid foods in the first 3 months of life. In the 1970s, guidelines introduced recommended delaying of introduction of solids until 4 months of age.⁶ Guidelines changed once again in the 1990s, recommending to delay solid foods until after 6 months of age and further delay of allergenic foods (such as eggs and nuts) until at least 2 years of age.⁶ Despite the recommendations for infant feeding to date, a lack of sufficient evidence exists to justify definitive recommendations for the timing of solid food introduction, specifically the potentially allergenic foods.⁶ With this history of evolving guidelines, an understandable amount of confusion exists surrounding infant feeding among both the public and professional audiences.

Currently, recommendations for the timing of introduction of complementary foods ranges from 4 to 6 months of age, with most health professionals in agreement that introduction prior to 4 months and later than 8 months of age has negative consequences.^{4,5} More evidence is necessary to specifically addresses the relationship between introduction of complementary foods and the

risk of developing disorders later in life. This research is required to identify an exact age of which complementary foods should be introduced to minimize risk of developing chronic disease.⁵ Evidence of the long-term consequences of the infant diet, however, is expanding rapidly to include other indices and markers, providing additional context to understand the longitudinal associations between early feeding and subsequent health outcomes.⁷ Recently, research that clarifies the timing, content, and method of complementary feeding is emphasized because of lasting effects on food preferences, appetite and eating behaviors as well as on obesity and the development and risk of allergy, among other conditions.⁸ As this evidence continually emerges, specific recommendations cannot be made at this time.

The National Health and Nutrition Examination Survey (NHANES) from 2009-2014 revealed 16.3% of U.S. children ages 6-36 months were introduced to complementary foods at less than 4 months of age while 12.9% were introduced at or after 7 months of age.⁴ These results, and the most recent evidence, indicate an opportunity for public health nutritionists to have a united voice and impact health in the first 1000 days of life and beyond.



Due to the ongoing emergence of evidence in infant feeding guidelines, there is a renewed challenge for public health nutritionists to relay consistent messaging to the general public. National and global authorities on health and nutrition provide recommendations for the timing of introduction of complementary foods for health care providers and the general public. Public health nutritionists who work in the maternal and child health field should formulate recommendations and messages from these guidelines.

— Current Feeding Guidelines —



World Health Organization (WHO)

The World Health Organization (WHO), the United Nations agency for international health, is committed to achieving better health for everyone, everywhere through their work producing international reference materials, making recommendations and setting standards, and working with governments and health professionals on the ground.

“WHO recommends that infants start receiving complementary foods at 6 months of age in addition to breast milk, initially 2-3 times a day between 6-8 months, increasing to 3-4 times daily between 9-11 months and 12-24 months with additional nutritious snacks offered 1-2 times per day, as desired.”

[WHO guidelines](#)

American Academy of Pediatrics (AAP)

Based upon evidence, a number of desired behaviors were identified as critical to helping families foster healthy active living for their infant: Breastfeeding, bottle feeding, food introduction, healthy snacking, foster self-feeding, and healthy drinks. Each desired behavior section contains information about evidence, parent feedback, opportunities for care and other information. “Introduce solid foods around 6 months of age. Expose baby to a wide variety of healthy foods. Also offer a variety of textures.”

[AAP guidelines](#)

The Centers for Disease Control and Prevention also promote the AAP guidelines through a parent-specific web site.

[CDC website](#)

Healthy Eating Research (HER)

Feeding Guidelines for Infants and Young Toddlers: A Responsive Parenting Approach provides evidence-based guidelines for feeding infants and toddlers during the first 2 years of life - created by an expert panel convened by Healthy Eating Research, a national program of the Robert Wood Johnson Foundation.

“Sometime between 4 and 6 months (when your baby is developmentally ready) your baby’s nutritional needs can no longer be met by breast milk or formula alone. At this time, gradually start introducing solid food by offering 1 to 2 teaspoons of a pureed or mashed food, slowly increasing the amount while paying attention to your baby’s hunger and fullness signals. If your baby is still hungry after consuming the small amount of solids recommended, then feed breast milk or formula.”³

[HER guidelines](#)

Child and Adult Care Food Program (CACFP)

The Child and Adult Care Food Program (CACFP) is a program of the United States Department of Agriculture (USDA) that provides aid to child and adult care institutions in order to provide nutritious foods that support wellness, healthy growth, and development to young children as well as health and wellness of older adults and chronically impaired disabled persons. The CACFP Infant Feeding Guide is being revised to match the updated infant meal requirements, and will be released soon.

“Solid foods are gradually introduced around 6 months of age, as developmentally appropriate.”

[CACFP fact sheet](#)

— Current Feeding Guidelines —

Guidelines Pending Release

The Dietary Guidelines for Americans (DGA) are the national nutrition policy set by the United States Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). Since its first edition in 1980, the DGA have provided nutritional and dietary information for Americans age 2 years and older. However, throughout the years there has been growing demand to address connections between early childhood nutrition and health outcomes throughout the lifespan. In 2012, the USDA and DHHS initiated the B-24 Project to inform the development of dietary recommendations for infants in toddlers separate from the DGA. In 2014, the DGA was expanded to include dietary guidelines for infants, toddlers, and women who are pregnant, and renamed the P/B-24 Project. National interest from the USDA to include guidelines for ages 0 to 2 in the 2020-2025 DGA further highlights the importance of infant feeding practices.⁹

The Women, Infants and Children Works Resource System (WIC Works) is an online education, training and resource center for state, local and clinic staff administering the Special Supplemental Nutrition Program for Women, Infants, and Children. It is a project of the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA). One of the many resources included on the site is a guideline sheet for staff, first published in 2017: [Guidelines for Feeding Healthy Infants](#). Coming soon, there will be an updated handbook (*Infant Nutrition and Feeding*) for WIC staff who provide nutrition education and counseling to the parents and caregivers of at-risk infants who participate in the WIC Program.

[Infant Nutrition Handbook link](#)



— Overweight and Obesity —

There are recurring themes in the literature that tie feeding practices, including breastfeeding and complementary feeding, to conditions such as overweight/obesity, allergies and anemia, among others. The following sections will highlight the recent major findings in these areas of research.

Overweight/Obesity

The prevalence of overweight and obesity in children is well established. In 2017, a study published in the *Lancet* analyzed weight and height in nearly 130 million people globally, including 31.5 million children aged 5-19 years of age. The number of obese children and adolescents rose from 11 million in 1975 to 124 million in 2016 – a tenfold increase.¹⁰

Looking at U.S. specific data, the National Health and Nutrition Examination Survey (NHANES) 2011-2012 measured heights and weights of 9120 persons including 584 infants and toddlers. Data from this survey found that 8.1% of infants and toddlers from birth to 2 years of age had a high weight for recumbent length (at or above the 95th percentile). While the prevalence of high weight for recumbent length was significantly greater for girls (11.4%) compared to boys (5%), no significant differences were found between the race/Hispanic origin groups.¹¹ In NHANES 2015-2016, infant and toddler data were not collected. Child and youth data can be found in the accompanying table.¹² The table was created to provide comparative data for NHANES data sets.

NHANES Comparison		
CHILDREN AGES	NHANES 2011-2012	NHANES 2015 - 2016
Children Ages 2 - 19		
% Overweight or Obese	31.8%	N/A (category not included in data)
% Obese	16.9%	18.5%
% Obesity Non-Hispanic Asian Youth	8.6%	11.0%
Non-Hispanic White Youth	14.1%	14.1%
Non-Hispanic Youth	20.2%	22.0%
Hispanic Youth	22.4%	25.8%
PREVALENCE OF OBESITY WITH INCREASING AGE GROUPS		
Children Ages 2 - 5	8.0%	13.9%
Children Ages 6 - 11	17.7%	18.5%
Children Ages 12 - 19	20.5%	20.6%
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2011 - 2012, 2015–2016.		



Prevalence of obesity is still increasing in children, with the greatest increase in toddlers. This confirms the importance of providing the best information and guidance early on and often so the messages are clear and consistent when possible.

— Overweight and Obesity —

Introduction and Timing of Complementary Feeding

Do complementary feeding practices predict the later risk of obesity?

While there are some correlations related to timing, there is not definitive evidence that supports the order or type of food given and the impact on obesity. Still, the influence on the risk of obesity incidence due to the nutritional exposure of the child from 4 to 24 months of age should be considered. This particular time of the child's life offers peculiar challenges, mainly due to the transition from breast/formula feeding to complementary feeding.¹³ In 2012, Grote et al. found that in industrialized countries, complementary feeding (the types of foods offered) has no major impact on obesity. However, there is some evidence that the age at introduction of complementary foods has some effect on growth in infancy. Introducing complementary foods before 4 months of age compared to 4-6 months was associated with an increased risk of being overweight or obese in childhood.¹⁴ However, in 2016, Wang et al, reported that no significant relationship was observed between delaying introduction of complementary foods after 6 months of age and being overweight or obese during childhood, while the introduction of complementary foods to infants before 4 months should be avoided to protect against childhood obesity.¹⁵ Introduction of solids prior to 4 months of age may result in increased risk of childhood obesity, but there is little evidence of adverse weight status outcomes associated with introducing solids at 4-6 rather than 6 months.^{16,17} More research is needed to link timing of complementary foods, including type of food, to obesity risk, and to provide more specific guidelines.



Obesity & Overweight: Introduction & Timing of Complementary Feeding

**No solid foods before 4 months.
Watch for and know the signs of
developmental readiness.**

GENERAL GUIDANCE

Signs of Readiness to Introduce Solid Food (based on AAP guidelines):

- The infant can sit up mostly on their own
- They can hold their head up for a long time
- They seem interested in mealtime—watching others eat, opening their mouth or reaching out when food is nearby, etc.
- The infant is hungry between nursing or bottle feeding
- The “tongue-thrust” reflex (where young infants automatically push food out of their mouth with their tongue) has faded

[Resource Link](#)



— Overweight and Obesity —



Breastfeeding

Until recently, breastfeeding has been inconsistently associated with lower infant obesity risk. However, this may be due to lack of clarification and isolation of feeding states in research. According to a recent study published in *Pediatrics*¹⁸ researchers typically do not distinguish between feeding at the breast and consuming bottled breast milk or between supplementation with infant formula versus foods, and few account for feeding in the hospital setting. This study also revealed a novel aspect that distinguishes it from other studies: the differentiation between partial breastfeeding supplemented with formula versus solid food. The results found that at 6 months, almost half (43%) of partially breastfed infants were receiving formula, whereas the remainder were being supplemented with solids only. Compared with exclusive breastfeeding, partial breastfeeding with formula was associated with faster weight gain, higher BMI, and a twofold increased risk of overweight by 12 months, whereas partial breastfeeding without formula (ie, with solids only) was not significantly associated with these outcomes. The optimal timing for introducing these foods remains to be determined, but this study suggests that introducing solids between 5-6 months does not adversely affect obesity-related outcomes. In fact, breastfeeding is inversely associated with weight gain velocity and BMI. These associations are dose dependent, partially diminished when breast milk is fed from a bottle, and substantially weakened by formula supplementation after the neonatal period.¹⁸

The International Journal of Environmental Research and Public Health, also confirmed the complexities of the preventative effect breastfeeding, stating, “The literature relies on observational studies, being considered unethical to randomize breastfeeding as an intervention.”¹³ In addition,

the significant differences between social and behavioral characteristics of the breast vs. formula feeding populations appear to bias the analysis.¹⁹ Careful consideration must then be reserved, reading through each publication, to the adopted breastfeeding definitions, particularly in terms of duration and/or exclusivity.²⁰

A Danish national birth cohort found that duration of breastfeeding and earlier introduction of complementary food (<4 mo) was not associated with higher BMI at age 7, but with a higher BMI at age 11 and increased risk of overweight at age 11.²¹ A recent meta-analysis of thirty prospective studies was conducted to determine the relative influence of every known potential risk factor for child obesity development. Comparing breastfed with non-breastfed infants, the authors found a 15% decrease in the odds of childhood overweight incidence.²² Thus, the most recent data are indicating that breastfeeding, particularly exclusive breastfeeding, combined with duration, and with appropriate introduction to complementary foods, provides some protective factors against obesity at later stages of life.

Other Findings

Formula-fed infants and infants who were breastfed for shorter than 4 months had a higher risk of being overweight during childhood when being introduced to complementary foods (CF) before 4 months of age.²³ Children who were breastfed for 12 months or more had a significantly lower risk of being overweight/obese than those breastfed less than 17 weeks; age of introduction of solid food was not associated with the risk of overweight/obesity at 24-36 months.²⁴



Obesity & Overweight: Breastfeeding

Breastfeeding is still best. Duration and exclusivity are important factors. Six months is preferred, but at least four months is still beneficial in relation to complementary feeding and obesity risk.

GENERAL GUIDANCE

— Allergies —



Allergies

A food allergy is defined as an adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food (World Allergy Organization). Food allergy is an important public health problem that affects children and adults and may be increasing in prevalence. Although more than 170 foods have been reported to cause IgE-mediated reactions (the standard indicator for allergen reactivity), most prevalence studies have focused on only the most common foods such as eggs, milk, peanuts, crustacean shellfish, and fish.²⁵

In 2010, the National Institute of Allergy and Infectious Disease (NIAID) published “Guidelines for the Diagnosis and Management of Food Allergy in the United States: Report of the NIAID-Sponsored Expert Panel” to address the increasingly important public health problem of food allergies.²⁵ These guidelines included recommendations relating to the timing of introduction of allergenic foods to infants stating that “introduction of solid foods should not be delayed beyond 4 to 6 months of age” including the introduction of potentially allergenic foods.²⁵

Introduction and Timing

The timing of introduction to certain foods may have an impact on food sensitivity. Since the release of the NIAID Guidelines, several other studies have provided additional insight for specific allergen-food culprits. There is evidence that beginning at 4 months and up to 11 months of age, timely introduction of peanuts into the infant diet reduces risk of peanut allergy in high-risk infants. There is some evidence that timely introduction of egg may reduce the risk of egg allergy. However, the role of timing for other allergenic foods has not been clearly established.²⁶ The majority of international guidelines recommend that complementary foods, including allergenic foods, can

be introduced from 4-6 months. Also, delayed peanut introduction, as well as delayed egg introduction, after 4-11 months of age may increase the risk of peanut allergy.²⁷

In support of the introduction of complementary foods between 4 and 6 months, these studies also highlighted emerging evidence supporting early rather than delayed peanut introduction during the period of complementary food introduction in infants.^{28,29} Conversely, *Clinics in Dermatology* reported that there is convincing evidence for the early introduction of peanuts, but not other allergenic foods.³⁰



— Allergies —

Additionally, increased diversity of complementary food, when combined with breastfeeding in the first year of life, was inversely associated with food allergy and food sensitization. This was found to be true in the Enquiring About Tolerance (EAT) study, which looked at 3-month old infants who were breastfed. The infants were randomized to either continue breastfeeding along with the sequential introduction of cow's milk, peanut, hard-boiled egg, sesame, white fish, and wheat or be exclusively breastfed until 6 months of age. Compared to the infants who were exclusively breastfed until 6 months of age, the infants in the early introduction group showed a reduction in peanut, egg and overall food allergies. However, there was no significant difference in the prevalence of milk, sesame, fish or wheat allergies between the two groups.³¹ However, safety and practicality remain key issues when extrapolating the results of this study to the general population. Open questions remain on the optimal timing and doses that should be used, and whether such regimens should be stratified according to the infant's allergy risk.²⁷ In brief, the guideline panel suggests introducing peanuts at home to the majority of infants in the first year of life. Infants with severe eczema, egg allergy, or both should undergo medical assessment including assessment of sensitization



to peanut before peanut introduction at 4–6 months of age. If other allergenic foods, such as egg, should also be actively introduced to the infant diet from 4 to 6 months of age remains undetermined.³²



Allergies: Introduction and Timing of Complementary Feeding

Introduce certain foods (eggs, peanuts, etc.) earlier, but not before 4 months and not past 11 months. Further assessments and discussion with the physician is required.

GENERAL GUIDANCE

— Breastfeeding and Alternatives —



Evidence that the mother should avoid eating highly allergenic foods while breastfeeding is also unclear. The composition of breast milk due to the mother's diet may have an impact on allergy development in the infant, but the variability of breast milk composition among mothers makes it tricky to establish universal recommendations.³⁶ One randomized controlled trial looked at egg consumption in breastfeeding mothers during the first six weeks of lactation. The mothers were randomly assigned to a high-egg, low-egg or no egg diet and the ovalbumin concentration of their breast milk was measured every 2 weeks. Higher maternal egg intake was associated with higher breast milk ovalbumin concentration and subsequently higher markers for immune tolerance in infants. This suggests that maternal diet during lactation could have a hand in allergy prevention.³⁷

For those infants who are not exclusively breastfed, for the first 4-6 months of life, multiple studies have identified the possibility of using hydrolyzed formula extensively to prevent or manage allergic disorders, including cows milk allergies. The data does not fully support the use of hydrolyzed formula for prevention, but does suggest that it imposes no harm when exclusively used for non-high-risk infants before 6 months of age.³⁸

Breastfeeding and Alternatives

Within the 2010 NIAID Guidelines, it is recommended that all infants should be breastfed until they are 4-6 months old, regardless of whether the infant is at a high risk for developing allergies. Under circumstances when exclusive breastfeeding is not possible, the guidelines do not recommend the use of soy-based formula over cow's milk formula.²⁵

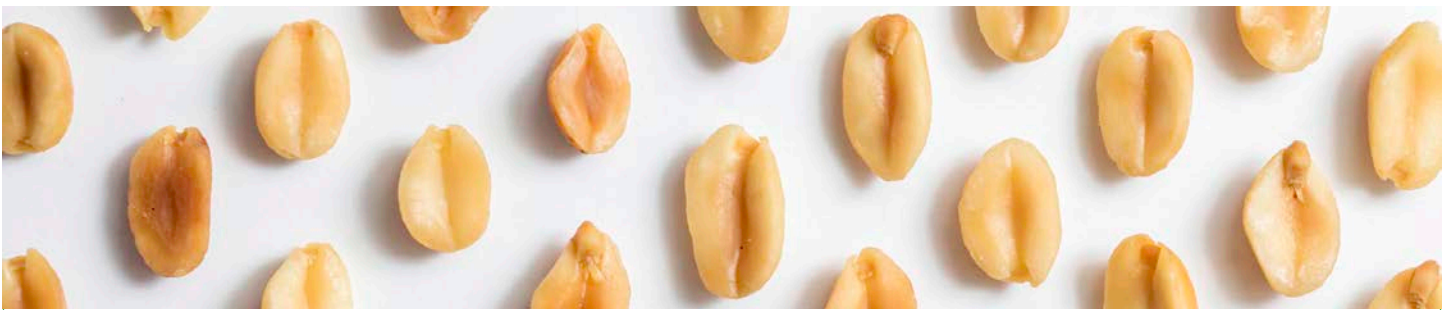
Whether or not breastfeeding is inherently preventative towards food allergies remains uncertain. Breastfeeding should be promoted for many health reasons, but more studies are needed to make a conclusion on the introduction of food allergens for the development of food allergies.³³ In a systematic review, influence of breastfeeding and an early exposure to gluten on risk of wheat allergy remain uncertain.³⁴ There is evidence that suggests the promotive effect of breastfeeding on gut bacteria colonization and diversity in infants, which could lead to healthy immune function and protection when complementary feeding is initiated. However, the role of the microbiota in the prevention of food allergies is still unclear.³⁵



— AAP Guidelines for the Prevention of Peanut Allergy —

Many children with food allergy reactions to these specific foods eventually will tolerate milk, egg, soy, and wheat; far fewer will eventually tolerate tree nuts and peanut. The time course of food allergy resolution in children varies by food and may occur as late as the teenage years.²⁵ There are guidelines that can assist with timing decisions.

In 2017, the American Academy of Pediatrics (AAP) endorsed new guidelines that outline a better approach to reduce the risk of peanut allergy: [*Addendum Guidelines for the Prevention of Peanut Allergy in the United States: Report of the National Institute of Allergy and Infectious Diseases-Sponsored Expert Panel.*](#)

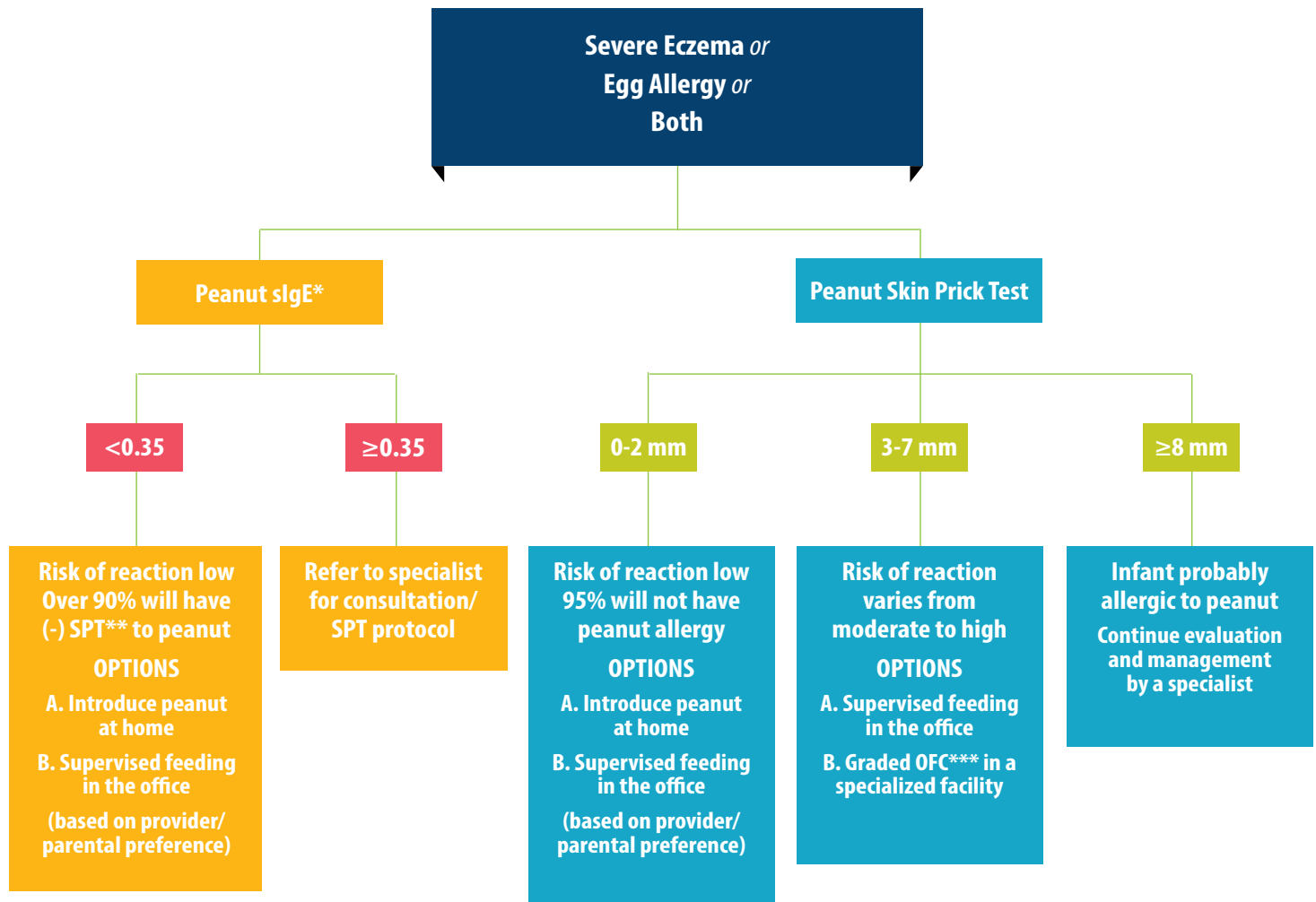


AAP GUIDELINES FOR THE PREVENTION OF PEANUT ALLERGY

The AAP guidelines are based primarily on the results of the landmark Learning Early About Peanut (LEAP) trial.³¹ The study randomized 640 infants from 4–11 months of age with severe eczema and/or egg allergy to ingest or avoid peanut until 60 months of age. The following represents a summary of the three updated guidelines:

1. Recommends that the highest risk infants — those with severe eczema and/or egg allergy — be introduced to peanut as early as 4–6 months of age, following successful feeding of other solid food(s) to ensure the infant is developmentally ready.
2. Suggests that infants with mild to moderate eczema, a group also at increased risk of peanut allergy, should be introduced to peanut “around 6 months of age, in accordance with family preferences and cultural practices, to reduce the risk of peanut allergy.”
3. Addresses infants without eczema or food allergy who are not at increased risk, suggesting that peanut be introduced “freely” into the diet together with other solid foods and in accordance with family preferences and cultural practices.

— AAP Guidelines for the Prevention of Peanut Allergy —



* To minimize a delay in peanut introduction for children who may test negative, testing for peanut specific IgE may be the preferred initial approach in certain healthcare settings. Food allergen panel testing or the addition of sIgE testing for foods other than peanut is not recommended due to poor positive predictive value.

** skin prick test

*** oral food challenge

This chart has been adapted from the *Addendum Guidelines for the Prevention of Peanut Allergy in the United States: Report of the National Institute of Allergy and Infectious Diseases-Sponsored Expert Panel*

Since these guidelines were released, a follow up study was conducted by Toit et al. in 2018. In the original LEAP study, early introduction of dietary peanut in high-risk infants with severe eczema, egg allergy, or both prevented peanut allergy at 5 years of age. The protective effect persisted after 12 months of avoiding peanuts in the 12-month extension of the LEAP study (LEAP-On). It was unclear whether this benefit was allergen and allergic disease specific. The follow up study sought to assess the effect of early introduction of peanut on the development of allergic disease, food

sensitization, and aeroallergen sensitization. Asthma, eczema, and rhinoconjunctivitis were diagnosed based on clinical assessment. The results found early consumption of peanut in infants at high risk of peanut allergy is allergen specific and does not prevent the development of other allergic disease, sensitization to other food allergens and aeroallergens, or reported allergic reactions to tree nuts and sesame. Furthermore, peanut consumption does not hasten the resolution of eczema or egg allergy.³⁹

Anemia and Iron

Iron is a mineral critical to infant somatic growth and neurodevelopment. It is most commonly recognized for its role in iron-deficiency anemia. It also has direct effects on brain maturation, and is an essential nutrient for development and cell growth in the immune and neural systems, as well as in regulation of energy metabolism and exercise.⁴⁰ Iron deficiency during infancy is associated with poor cognitive and behavioral outcomes that may persist after iron repletion. Therefore, ensuring adequate iron stores in infancy is essential.⁴¹

It should be noted that the majority of evidence-based, large-scale studies looking at anemia as it relates to introduction and timing of complementary foods and breastfeeding, are on the global scale. These studies often did not differentiate the introduction and timing of complementary foods versus breastfeeding, but looked at them collectively.^{42,43,44,45,46,47}

Introduction, Timing and Breastfeeding

In the Feeding Infants and Toddlers Study (FITS) study of 3274 children age 0-47 months⁴⁸ formula fed and breastfed infant and toddler data were collected and analyzed from 24-hour dietary recall. Iron intakes from infant formula and breastmilk were also excluded in a separate analysis to determine iron intakes from complementary foods only. Results found that users of infant cereal (compared to non-users) had significantly higher mean intake of iron from the total diet (including infant formula and breastmilk) across

all age groups. Meat contributed only a small percentage to total dietary iron across all age groups. Infants who did not consume infant cereal had iron intakes 50–60% less than consumers of iron-fortified infant cereals. Although more non-users of infant cereal consumed meats than cereal users, the types of meats consumed were not iron-rich sources, like turkey, chicken or processed meats.⁴⁸ While this study did not measure or quantify anemia in infants, it did provide evidence for the importance of the introduction of iron-fortified cereal for breastfed and formula fed infants.

A smaller, earlier study conducted a comparative analysis of iron status in exclusively breastfed infants, randomized for either pureed beef or iron-fortified infant cereal as first complementary food. Results revealed at 5 and 7 months protein and zinc intake were significantly higher in the meat group but iron intake was higher at 7 months in the cereal group. After 7 months there were no differences in energy or micronutrient intakes between groups (protein was somewhat higher at 9 months in meat group). Overall conclusions indicated that introduction of meat as an early complementary food for exclusively breastfed infants is feasible and was associated with improved zinc intake and potential benefits. The high percentage of infants with biochemical evidence of marginal zinc and iron status suggests that additional investigations of optimal complementary feeding practices for breastfed infants in the United States are warranted.⁴⁹



Anemia & Iron: Introduction, Timing & Breastfeeding

These data are still inconclusive, but there is some evidence to support early introduction of iron-fortified cereal and possibly meat for breastfed and formula fed infants.

GENERAL GUIDANCE

— Anemia and Iron —



International Studies

A meta-analysis of randomized-controlled trials and observational studies was conducted in 2015.⁵⁰ The focus was the introduction of complementary foods at 4 months versus 6 months of age among healthy, full-term, exclusively breastfed infants. The conclusions differentiated between recommendations for addressing anemia in developing countries vs. developed. Infants in developing countries showed greater iron levels (hemoglobin & ferritin) when complementary foods were introduced at 4 months, compared to those who were exclusively breastfed until 6 months of age. Summary data indicate that the generalized

the current statement regarding solid introduction to a range of (4–6 months), leaving individual decisions to health care professionals and parents. Larger randomized controlled trials in developed and developing countries are needed to further investigate the differences in outcomes after introduction of solids before and at 6 months of age.”⁵⁰

Recommendations for Supplementation

In 2016, The World Health Organization (WHO) published a systematic review of trials involving infants and children 4-23 months of age and found those who received daily iron supplementation had a lower risk of iron deficiency anemia compared to those who did not receive iron. Based on these findings, WHO created recommendations as a public health intervention to prevent iron deficiency anemia. WHO strongly recommends infants and children 6-23 months of age who live in areas where the prevalence of anemia is 40% or higher to receive daily iron supplementation of 10-12.5 mg iron in the form of drops/syrups.⁴⁰

AAP published the “Clinical Report—Diagnosis and Prevention of Iron Deficiency and Iron-Deficiency Anemia in Infants and Young Children (0–3 Years of Age)”, which includes the recommendation that exclusively breastfed term infants receive an iron supplementation of 1 mg/kg per day, starting at 4 months of age and continued until appropriate iron-containing complementary foods have been introduced. This recommendation applies to infants receiving at least half of their daily feedings as human milk. For infants receiving primarily formula, AAP concluded that formula containing 12 mg/L elemental iron is safe for the intended use.⁵¹ While the AAP report was released in 2010, as opposed to the WHO report in 2016, it has a more direct implication for the U.S. demographic.



recommendation to introduce solid foods at 6 months of age may not be optimum for all healthy, breastfed infants, and that iron status of healthy full-term infants could be positively altered by an earlier introduction of complementary foods. Thus, there may be value in changing

— Anemia and Iron —



According to a report published in the Academy of Breastfeeding Medicine, iron supplementation is not required for the non-anemic breastfeeding mother. Iron supplementation to the 4-month-old full-term, exclusively breastfed infant is associated with improved hematological indices. However, the long-term benefit of improved hematologic indices at 4–6 months is not known. The report goes on to agree/align with AAPs recommendation: If iron supplementation is given before 6 months, it should be given as a 1 mg/kg/day distinct iron supplement until iron-fortified cereals (7–7.5 mg ferrous sulfate/day) or other iron-rich foods such as meat, tofu, beans, and others are initiated at 6 months of age with other complementary foods.⁴¹

There is overarching evidence and agreement that complementary foods, including iron-rich foods, should be introduced between 4-6 months, particularly when women are exclusively breastfeeding. There are still conflicting data when reviewing the efficacy of breastfeeding and the introduction (timing and content) of complementary foods in association of anemia risk. Although breastmilk is not a rich source of iron for infants, breastfeeding is still generally recommended until complementary food introduction at 4-6 months of age since the iron stores the infant accumulated during fetal development seems to be adequate for that amount of time. Once complementary food introduction begins, more discussion is needed about what foods should be introduced.^{48,49,52}



Key Concepts

Continue to reiterate the importance of and advocate for interventions that focus on the time span between conception and one's second birthday.

There are evolving guidelines that support the importance of timing of introduction for complementary foods - between 4 and 6 months, or when the baby is developmentally ready and shows signs of readiness.

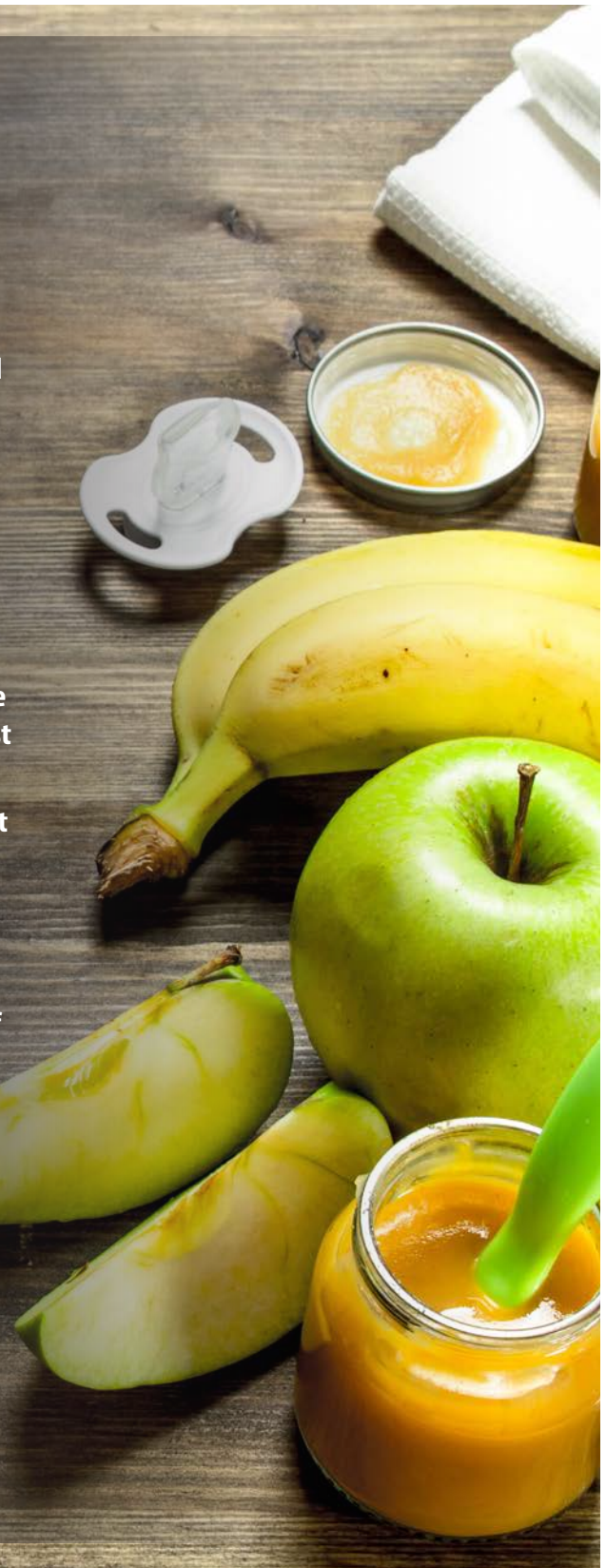
Formulate educational messages and recommendations on current feeding guidelines and monitor guidelines for updates (WHO, AAP, HER, CACFP, WIC, USDA, etc.).

While there are some correlations related to timing, there is not definitive evidence that support the order or type of food given and impact on obesity. Recent evidence does support breastfeeding/exclusive breastfeeding, along with appropriate timing of complementary feeding as a protective factor against infant and child obesity.

The timing of introduction to certain foods may have an impact on food sensitivity and allergens. The prevention of allergies is complicated, but there is new guidance on introduction protocols and assessments (AAP), and emerging data (LEAP, du Toit et. al) that can be utilized.

Introduction protocols align with general recommendations of complementary foods, with greater diversity of foods offered, between 4 and 6 months.

There is overarching evidence and agreement that complementary foods, including iron-rich foods, should be introduced between 4-6 months, particularly when women are exclusively breastfeeding. There is evidence to support the introduction of iron-fortified cereal, and potentially pureed meat, for breastfed and formula fed infants to increase iron status and for the prevention of anemia. Guidance for iron supplementation is provided by the WHO and AAP.



— Additional Resources —



American Academy of Pediatrics

- [AAP Interactive Guide for Timing of Feeding Practices](#)
- [Tips for Introducing Solid Foods](#)
- [Starting Solid Foods](#)
- [When Can I Start Giving My Baby Peanut Butter](#)

Centers for Disease Control

- [CDC Resources for Infant and Toddler Nutrition](#)
- [CDC - Infant Feeding Practices Study II - and 6-year follow-up \(Y6FU\)](#)
- [CDC - Breastfeeding Data, Guidelines and Recommendations](#)

USDA

- [P/B - 24 Project - USDA](#)
- [USDA WIC Studies and Research related to infant feeding](#)
- [National WIC Association Research Activities](#)
- [USDA WIC Works Resources](#)
- [Guidelines for Feeding](#)
- [Coming soon: Infant Nutrition and Feeding Handbook](#)

CACFP

- [Nutrition Standards for CACFP Meals and Snacks](#)

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Cite as: Shana Patterson, RDN, in collaboration with ASPHN's Maternal & Child Health Nutrition Council, 2018. *Guidelines and Health Conditions Related to Timing of Early Infant Feeding: A Review*. Retrieved from the Association of State Public Health Nutritionist's website, <https://asphn.org/wp-content/uploads/2018/11/Guidelines-and-Health-Conditions-Related-to-Timing-of-Early-Infant-Feeding.pdf>.

Supported in part by the Health Resources and Services Administration, Maternal and Child Health Bureau (contract #HHS250201300026C)

Thank you to ASPHN student member contributions from Noelle Yeo, University of Minnesota, and Jessica O'connell, University of Minnesota.



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